FACTS ABOUT

USDA GRADING STANDARDS FOR CORN

Corn has long been a food staple in many countries of the world. Even in the United States, the cultivation of corn predates the colonization of this country by European settlers.

As the leading U.S. crop, both in volume and value of production, U.S. corn accounts for nearly half of the world production of the crop, and for the bulk of international trade in corn.

To facilitate grain marketing for both domestic and export grain and commodities, the United States Department of Agriculture (USDA) developed official standards in 1917, under the United States Grain Standards Act (U.S.G.S.A.)[1], most recently amended in 1977. These standards[2] are the responsibility of the Federal Grain Inspection Service (FGIS) and serve as an internationally recognized means of communicating grain quality and condition.

The standards identify and measure certain properties of grain and define those characteristics that denote quality. Official grades, provided by the standards, serve to describe and qualify the level of that quality.

The standards are generally based on selected physical attributes of the whole kernel of grain. Most of these attributes must currently be determined by subjective analyses. However, attempts are being made to develop more objective methods of determining corn quality, particularly as it relates to end use. This fact sheet outlines the procedure for applying official U.S. grades to samples of corn.

How are the Grading Factors Used?

Six grades are used to define corn quality. One of the five numerical grades or "Sample grade" is assigned to a "lot" of corn based on the analysis of a representative sample. A "lot" is a specific quantity of grain. The factors contributing to the quality determinations in corn include test weight, moisture, broken corn and foreign material, total damaged kernels, heat damaged kernels. distinctly low quality elements, odors, class and special grades.

The grade is determined by the lowest quality factor. For example, if the moisture content of a sample is above 15.5 percent, it will grade no higher than No. 3 even though it may be No. 1 on all other factors. This is because the maximum amount of moisture allowed in No. 1 is 14.0 percent and in No. 2 the maximum allowed is 15.5 percent.

Four of the grading factors are determined as percentages based on the weight of the portion used for analysis. These four factors are moisture, broken corn and foreign material, damaged kernels and heat-damaged kernels. Portions used for these determinations are obtained from the sample by use of an FGIS-approved divider. This apparatus is used to reduce the sample to workable portions that remain representative of the lot from which they were taken.

[1,2] Cited in Reference section, page 7.

The following chart shows the breakdown of a sample for the determination of factors. The size of the portion used for factor determinations is shown in grams.

LOT AS A WHOLE

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Determine

1. Live insects
2. Heating (developing high temperatures due to excessive respiration)
3. Distinctly Low Quality (DLQ)

OBTAIN REPRESENTATIVE SAMPLE

SAMPLE AS A WHOLE

File Sample (1000 gms.) ← → Moisture Sample (250 gms.)

↓

WORK SAMPLE (1000 gms.)

Determine

1. Conformance to definition of corn (250 gms.)
2. Odor (1000 gms.)
3. Insects (1000 gms.)
4. Stones (1000 gms.)
5. DLQ (1000 gms.)
6. Test weight (1000 gms.)

REMOVE BROKEN CORN AND FOREIGN MATERIAL (BCFM) (1000 gms.)

(Mechanical determination) → BCFM

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REMOVE COARSE FOREIGN MATERIAL (FM) (1000 gms.)

(Handpicked determination) → FM

↓

250 gms.
(BCFM-free)

Determine

1. Heat damaged kernels (250 gms.)
2. Damaged kernels total (250 gms.)
3. Corn of other colors (250 gms.)
4. Special grades (flint, flint and dent — 250 gms.)
   (Waxy — 100 kernels)
   (Weevily — lot as a whole and/or the representative sample before the removal of BCFM)

The following grading table shows the limits of five factors considered in determining the grade of a sample of corn. For test weight, the minimum limits for each grade are used. For the other factors, maximum limits are used.

Grade	Minimum test weight per bushel	Maximum limits of—			
		Moisture	Broken corn and foreign material	Damaged kernels	
				Total	Heat—damaged kernels
	Pounds	*Percent*	*Percent*	*Percent*	*Percent*
U.S. No. 1	56	14.0	2.0	3.0	0.1
U.S. No. 2	54	15.5	3.0	5.0	.2
U.S. No. 3	52	17.5	4.0	7.0	.5
U.S. No. 4	49	20.0	5.0	10.0	1.0
U.S. No. 5	46	23.0	7.0	15.0	3.0
U.S. Sample grade	U.S. Sample grade shall be corn which does not meet the requirements for any of the grades from U.S. No. 1 to U.S. No. 5, inclusive; or which contains stones; or which is musty, or sour, or heating; or which has any commercially objectionable foreign odor; or which is otherwise of distinctly low quality.				

How are Grades Determined?

The first determination made on a sample is to qualify the grain as corn. According to the official standards, a lot of corn must consist of 50 percent or more of whole kernels of flint corn and/or dent corn and may contain no more than 10.0 percent of other standardized grains. Once the sample has met these requirements, the grade determining factors are measured and the sample is assigned a "grade designation."

The grade designation or "official grade" includes the numerical grade or "Sample grade" designation, the name of the applicable class, and any applicable special grades. Special grades include Flint corn, Flint and Dent corn, Weevily corn, and Waxy corn.

The application of grading factors is discussed below.

Test Weight Per Bushel

Test weight per bushel of grain, in general, measures the density of the kernel. The test weight of a sample of corn is determined on the sample as a whole -- that is, before the removal of broken corn and foreign material (BCFM). Approximately 1-1/8 quarts of corn are used to determine the weight per bushel of the sample, using a test weight apparatus approved by FGIS.

Although corn millers once believed that heavier test weights were an indication of better milling quality, tests have shown no conclusive relation between the two. However, studies have indicated that the apparent digestibility of nutrients increased as test weight increased.

Moisture

The moisture content of corn is determined on a 250-gram portion of a sample, before the removal of BCFM, using an FGIS-approved moisture measuring device, such as

the Motomco moisture meter.[3] Although moisture does not appear to have any adverse effect on the nutritive value of corn, it does affect the long-term storage of the grain. Usually, the higher the moisture content of the grain, the quicker it will deteriorate. High moisture corn offers a prime media for invasion by molds and fungi, and does not store well for long periods of time. High moisture also contributes to "heating," and sour or musty odors. Drying is expensive and may, if not accomplished properly, cause other undesirable conditions such as drier damaged and heat-damaged corn, and increased BCFM due to stress cracked kernels which can break during handling.

Broken Corn and Foreign Material

The factor of BCFM usually has little effect on nutritive value since it generally consists of fragmented kernels of corn or other grains. However, like moisture, high levels of BCFM affect the long-term storage of corn due to its tendency to concentrate in small areas during handling. These areas become prime targets for mold or insect infestation since these kernel fragments are no longer protected by a seed coat. Combined with high moisture, BCFM contributes to heating, and sour or musty odors.

Large amounts of BCFM cause difficulty in corn processing since it reduces yields of products obtained from a bushel of raw material and does not temper in the same manner as whole, sound kernels.

This factor is based on a 1,000-gram portion of a sample, using both mechanical and handpicked determinations. A 12/64-inch (4.762 mm.) round hole sieve inserted into a Carter Dockage Tester separates the fine BCFM from the larger kernels of corn. Everything other than corn that does not pass through the sieve, is separated from the corn by hand and added to the machine separated screenings to be calculated as BCFM.

Damaged Kernels

Kernels and pieces of kernels of corn which are heat damaged, badly weather damaged, moldy, diseased, sprouted, frost damaged, or otherwise materially injured are considered to be damaged kernels. This handpicked determination is made on a 250-gram portion of a corn sample after the removal of BCFM. To be considered damaged, the injury must be distinctly apparent.

Damage is used as a grading factor in corn since corn millers and livestock feeders require a relatively sound product. Different types of damage have varied effects on the end products of corn. Kernels with diseased germs or damaged by heat may affect the color of the flour or meal and may change the flavor and even nutritional value of items made from these milled products.

Sufficient quantities of some types of mold damage in livestock feed can cause lower rates of gain, weight loss, illness, and even death. Molds can produce mycotoxins, such as aflatoxin. Even in small amounts, aflatoxin can cause

[3] The mention of firm names or trade products does not imply that they are endorsed or recommended by the Federal Grain Inspection Service over other firms or similar products not mentioned.

pathologically recognizable damage in poultry, cattle, and swine months after the feeding of contaminated corn has ceased.

Heat-Damaged Kernels

Heat damage is considered more undesirable than other types of damage, especially in milled products. For this reason, heat damage is an individual grading factor as well as being included in the percentage of total damage. Heat-damaged kernels are handpicked on a 250 gram portion of the BCFM-free sample. Since heat damage may adversely affect color and flavor of milled products, only minimal amounts are allowed in the higher grades.

Most heat-damaged corn is utilized in the livestock feeding industry. Although studies have shown that roasted corn may be beneficial to livestock, corn that has sustained severe heat damage may, when fed at high levels, have an adverse effect on rate of gain.

Heat-damaged kernels may be the result of heating caused by excessive respiration or excessive external heat. Kernels must be materially discolored and damaged, showing indications of burn damage to be considered heat-damaged.

Distinctly Low Quality

When a sample is determined to be of very low quality due to the presence of highly undesirable factors, it is automatically designated to be of "distinctly low quality" (DLQ). Some indications of DLQ include the presence of large stones, glass, concrete, other wreckage or debris, castor beans, cockleburs and other thorn-like seeds, or crotalaria seeds either in the sample or in the lot as a whole. These must be present in sufficient quantities to render the corn unsuitable for its intended use.

Lumps, dead animals (such as rodents or birds), rodent excreta, unknown foreign substances, contamination by fertilizer, or any other unusual conditions adversely affecting the quality of the corn, also make the sample distinctly low quality. Any sample found to be DLQ cannot grade higher than "Sample grade."

Odors

Corn with musty or sour odors, or which is heating or has a commercially objectionable foreign odor (COFO), will grade no higher than "Sample grade." Odors considered commercially objectionable include odors of fertilizer, hides, oil products, skunk, smoke, fire-burnt grain, decaying animal and vegetable matter, and certain fumigants. These odors are considered COFO because they are entirely foreign to grain and render the grain unfit for normal commercial usage.

What Other Elements Contribute to the Final Grade?

Class

Following the numerical grade or Sample grade determination in the grade designation is the name of the applicable class. The official standards divide corn

into three classes: white corn, yellow corn, and mixed corn. The official standards define them as follows:

> White corn consists of white kerneled corn and may contain not more than 2.0 percent of corn of other colors.
>
> Yellow corn consists of yellow kerneled corn and may contain not more than 5.0 percent of corn of other colors.
>
> Mixed corn is corn that does not meet the color requirements of the other two classes.

The analysis for class is made on a 250-gram portion of the sample after the removal of BCFM.

Special Grades

After the class name in the grade designation, any applicable special grade(s) may be listed.

The special grade of "Flint" is added to the grade designation for a sample following the name of the class, if the sample is determined to consist of 95 percent or more of flint corn.

"Flint and Dent" is determined on the same basis as "Flint" and is added to the grade designation if the sample contains more than 5 percent but less than 95 percent of flint corn.

To be graded "Weevily," one of the following conditions must exist, based on the sample or the lot as a whole:

*Two or more live weevils are present.
*One live weevil and five or more other live insects injurious to stored grain are present.
*Fifteen or more other live insects injurious to stored grain, including angoumois moths, are found in, on, or about the lot offered for inspection.

One live weevil is considered incidental and is not enough evidence to cause the corn to grade "Weevily." However, it indicates that the corn may be infested and should be inspected carefully for further evidence of live insects.

The special grade of "Waxy" is applied to a sample of corn that consists of 95 percent or more of waxy corn as determined by use of a chemical test using an iodine solution. This test is described in the Grain Inspection Handbook, Grain Grading Procedures - Book II[4], and is based on 100 kernels of corn randomly selected from the sample after the removal of BCFM.

CERTIFICATION

The inspection results, based on the "Official United States Standards for Corn," are recorded on an official grain inspection certificate approved by the FGIS.

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[4] Cited in Reference section, page 7.

This certifies the grain's kind, class, grade, quality, condition, and quantity, or other facts relating to the grain at the time and place of inspection. The results of all factor determinations and any information pertinent to the grain's quality or condition are recorded on the certificate.

The certificate is issued under the authority of the USGSA as amended and is internationally recognized as an acceptable record of the quality of the grain at the time of inspection. It is also recognized that the certificate may not represent the grain's grade, quality, or condition at a subsequent date or place.

How Well do Standards Reflect Quality?

Although the official grading standards were developed to give an accurate appraisal of a specific lot of grain, the grade can only be as accurate as the sample representing the entire lot. If the sample obtained is not representative, no amount of care in making the determinations for the grading factors will establish the true grade of the grain involved.

The current corn standards have remained basically intact since they became effective in December 1917. Changes in corn production, harvesting, and utilization have caused minor revisions but no major alterations. Periodic review of the Official U.S. Standards for Corn by FGIS to insure their current relevance to the industry has not resulted in significant changes to date, indicating that the standards adequately serve the needs of those who utilize them.

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REFERENCES

1. The Federal Grain Inspection Service, "United States Grain Standards Act As Amended," U.S. Department of Agriculture, Washington, D.C., November 1977.

2. The Federal Grain Inspection Service, "The Official United States Standards for Grain," U.S. Department of Agriculture, Washington, D.C., Jan. 1978.

3. The Federal Grain Inspection Service, "Grain Inspection Handbook - Book II: Grain Grading Procedures," United States Department of Agriculture, Washington D.C., January 1980.

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SPECIAL NOTICE

Due to an error in the September 1980 edition mailed earlier, we are asking you to discard it and replace with this copy

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